



# UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
United States Patent and Trademark Office  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/534,900	10/07/2005	Ian Kinloch	UDL-002	1909
51414 7590 03/05/2008 GOODWIN PROCTER LLP PATENT ADMINISTRATOR EXCHANGE PLACE BOSTON, MA 02109-2881				
EXAMINER HAILEY, PATRICIA L				
ART UNIT		PAPER NUMBER		
1793				
MAIL DATE		DELIVERY MODE		
03/05/2008		PAPER		

**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

### Office Action Summary

**Application No.**

10/534,900

**Applicant(s)**

KINLOCH ET AL.

**Examiner**

PATRICIA L. HAILEY

**Art Unit**

1793

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 07 October 2005.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-37 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-37 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some \* c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO/SI/02)  
Paper No(s)/Mail Date \_\_\_\_\_
- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date \_\_\_\_\_
- 5) ☐ Notice of Informal Patent Application
- 6) ☐ Other: \_\_\_\_\_

Applicants' Preliminary Amendments, filed on May 13 and October 7, 2005, have been made of record and entered. No claims have been canceled or added; claims 1-37 remain pending in this application.

### ***Priority***

1. Receipt is acknowledged of papers submitted under 35 U.S.C. 119(a)-(d), which papers have been placed of record in the file.

Applicants' Priority Document was filed on May 13, 2005.

### ***Claim Objections***

***2. Claim 14 is objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form.***

Claim 14 fails to further limit the subject matter of claim 13, from which it depends. Claim 14 recites exemplary substrate particles that are not recited in claim 13; it appears that claim 14 should depend from claim 1.

### ***Claim Rejections - 35 USC § 103***

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the

Art Unit: 1793

invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148

USPQ 459 (1966), that are applied for establishing a background for determining

obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

5. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

**6. *Claims 1-7, 9-13, 20, 21, 24, 25, and 32-36 are rejected under 35 U.S.C. 103(a) as being unpatentable over WO 00/17102 (hereinafter "the WO document").***

The WO document teaches a method for the production of single-wall carbon nanotubes, wherein a supported transition metal catalyst (supported on an inert surface) is brought into contact with a suitable feedstock gas at a temperature and pressure at

which single-wall carbon nanotube growth occurs. See page 4, lines 20-24 of the WO document.

The transition metal catalyst may be provided on a chemically compatible, refractory nanoscale support particle. Examples of the support include alumina, carbon, quartz, silicates, and aluminum silicates; the support may take the form of spheres, irregularly shaped particles, flakes, and the like. Preferred are supports that provide substantially planar surfaces, e.g., flakes; further, the support "may range in size from about 10 nm to centimeters." See page 8, line 26 to page 9, line 2 of the WO document (considered to read upon **claims 12 and 35**--if the length and breadth of the particle faces are of the same size--as well as **claims 3 and 13**).

Examples of the transition metal catalyst include metals such as iron, cobalt, nickel, molybdenum, and mixtures thereof. See page 9, lines 4-18 of the WO document (considered to read upon **claims 20 and 21**).

The transition metal clusters may have a size of from about 0.5 nm to over 30 nm. The transition metal clusters may be dispersed on the support surface so that there is clear separation between the clusters, so that the single-wall nanotubes that grow from the support are separate from one another. See page 9, lines 19-30 of the WO document (considered to read upon **claims 4-6**).

The catalyst may be prepared using known methods, and can be prepared in advance in fully active form, prepared in precursor form followed by an activation step, or formed in situ in the reaction zone. See page 9, line 31 to page 10, line 7 of the WO document (considered to read upon **claims 7 and 9-11**).

Examples of the feedstock include suitable carbon-containing compounds such as carbon monoxide, benzene, toluene, xylene, cumene, ethylbenzene, naphthalene, phenanthrene, anthracene, methane, ethane, propane, ethylene, propylene, acetylene, formaldehyde, acetaldehyde, acetone, methanol, ethanol, or mixtures thereof. See page 10, lines 15-23 of the WO document (considered to read upon **claims 24 and 25**).

In the method disclosed by the WO document, the reaction temperature ranges from about 700°C to about 1200°C. Additionally, the carbon feedstock may be recycled through the reactor to increase utilization of the feedstock. See page 12, lines 12-20 of the WO document (considered to read upon **claims 33 and 34**).

The carbon nanotubes produced by the method disclosed in the WO document exhibit diameters ranging from about 0.5 to about 3 nm, and may have lengths exceeding 1 micron. See page 15, lines 18-25 of the WO document (considered to read upon **claim 36**).

Additionally, nanotubes prepared according to this method may be removed from the supported catalyst for subsequent processing and/or utilization, or may be used "as is" while still attached to the catalyst particle. They may also be collected individually for particular uses. See page 16, lines 2-8 of the WO document (considered to read upon **claim 32**).

The WO document does not explicitly teach that the support exhibits radii of curvature of more than 1  $\mu\text{m}$  or more than 10  $\mu\text{m}$ , or a length and breadth between 1  $\mu\text{m}$  and 5 mm, or between 10  $\mu\text{m}$  and 500  $\mu\text{m}$ . However, because the WO document discloses that the support can have substantially planar surfaces, can be irregularly

Art Unit: 1793

shaped particles, and may "range in size from about 10 nm to centimeters" (page 8, line 26 to page 9, line 2), it would have been obvious to one of ordinary skill in the art at the time the invention was made to select support particles within the disclosed size range that would also exhibit radii of curvature greater than 1 or 10  $\mu\text{m}$ , motivated by the teachings of the WO document, and by Applicants' claim limitations regarding the length and breadth of the substrate/support particles, which implies that the length and breadth can be identical or nearly so.

**7. Claims 1, 2, 7, 9, 11-13, 15, 18-22, 24, 25, 29-34, 36, and 37 are rejected under 35 U.S.C. 103(a) as being unpatentable over Resasco et al. (U. S. Patent No. 6,413,487).**

Resasco et al. disclose a method for producing carbon nanotubes, wherein catalytic particles are subjected to exposure of an effective amount of a carbon-containing gas (such as carbon monoxide, aliphatic hydrocarbons, both saturated and unsaturated, oxygenated hydrocarbons, aromatic hydrocarbons, etc., which may optionally be mixed with a diluent gas, see col. 8, lines 10-22 of Resasco et al.; considered to read upon **claims 24, 25, and 29**), that is heated to a suitable reaction temperature (e.g., about 750°C, see col. 10, lines 47-51; considered to read upon **claim 34**), during which stage carbon nanotubes and amorphous carbon are formed on the catalytic particles. See col. 4, lines 16-26 of Resasco et al.

The catalyst particles comprise a solid support material which first has been impregnated with a metallic catalyst, then calcined and preferably processed into a

pellet form, followed by treatment with an inert gas and with a reducing gas. The pelletization process can be performed either before or after the support material is impregnated with the catalyst (transition metal precursor). See col. 2, lines 33-45 of Resasco et al.; considered to read upon **claims 7, 9, 11, 18, and 19**).

Examples of the catalytic metals include cobalt, nickel, and molybdenum. See col. 7, lines 12-62 of Resasco et al. (considered to read upon **claims 20-21**), which also discloses exemplary catalytic metal precursor compounds such as bis (cyclopentadienyl) cobalt or bis (cyclopentadienyl) molybdenum chloride (considered to read upon **claim 22**), and exemplary supports (silica, alumina, zirconium oxide, MCM-41—Mobil Crystalline Material-41, magnesium oxide, or other oxidic supports known in the art; considered to read upon **claim 13**, as well as the limitation "anisotropic" in **claim 15**).

The process of Resasco et al. involves bringing heated catalytic particles into contact with a heated carbon-containing gas in a reactor enables for the gases supplied thereto to be recycled after having been output from said reactor. See col. 12, lines 7-26 of Resasco et al. (considered to read upon **claim 33**).

The process of Resasco et al. may be a fluidized bed or quasi-continuous batch and fluidized bed process. See col. 12, line 47 to col. 13, line 45 of Resasco et al. (continued to read upon **claims 30 and 31**).

The amorphous carbon particles are burned away from the catalytic particles via oxidation, substantially leaving only carbon nanotubes in the particles. The catalytic particles are then subjected to a purification process which results in the separation of



Art Unit: 1793

the catalysts (bearing the nanotubes) from the support, for example, by dissolving by treatment with a base. See col. 4, lines 34-61 of Resasco et al. (considered to read upon **claims 32, 36, and 37**).

Resasco et al. does not disclose that the supports therein exhibit radii of curvature of more than 1  $\mu\text{m}$  or more than 10  $\mu\text{m}$ , or a length and breadth between 1  $\mu\text{m}$  and 5 mm, or between 10  $\mu\text{m}$  and 500  $\mu\text{m}$ . However, because Resasco et al. discloses supports reading upon that instantly claimed, and also discloses a process comparable to that instantly claimed, it would have been obvious to one of ordinary skill in the art at the time the invention was made to reasonably expect the supports of Resasco et al. to exhibit properties such as radii of curvature, length, and breadth, in values or amounts comparable to that instantly claimed, absent the showing of convincing evidence to the contrary.

**8. Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over WO 00/17102 or Resasco et al. (U. S. Patent No. 6,413,487) as applied to claims 1 and 7 above, and further in view of Hwang et al. (U. S. Patent No. 6,855,376).**

Both the WO document and Resasco et al. are relied upon for their teachings with respect to claims 1 and 7. Although both references disclose exemplary methods for depositing catalyst material onto a support, neither reference teaches or suggests the techniques recited in claim 8.

Hwang et al. disclose a process of direct growth of carbon nanotubes, wherein a metal support layer is formed on a substrate, a metal catalyst layer is formed on said

metal support layer, a bonding layer is formed on said catalyst metal layer, and carbon nanotubes are grown on a surface of said multi-layered substrate, under conditions of a reaction temperature of 400°-600°C and a carbon source gas comprising a hydrocarbon or carbon monoxide (col. 4, lines 26-30 of Hwang et al.; note that the carbon source gas is comparable to the carbon-containing gases disclosed in both the WO document and Resasco et al., and that the temperature range of Hwang et al. falls within the range disclosed in the WO document).

The metal catalyst layer comprises a metal selected from the group consisting of Fe, Co, Ni, and an alloy thereof (note that these metals are recited in both the WO document and in Resasco et al.), and is formed by vacuum sputtering, CVD, physical vapor deposition (PVD), screen printing, or electroplating. See col. 3, lines 45-58 and col. 4, lines 9-12 of Hwang et al.

In view of the similarities between Hwang et al., the WO document, and Resasco et al., regarding the respective methods/conditions of producing carbon nanotubes and the respective catalysts disclosed therein, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of either the WO document or Resasco et al. by incorporating therein the catalyst deposition techniques disclosed in Hwang et al., as these references show exemplary techniques for depositing a catalyst onto a substrate, said catalyst being employed in methods for producing carbon nanotubes.

**9. Claims 4-6, 14, 16, 17, 20, 21, and 24-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Resasco et al. (U. S. Patent No. 6,413,487) as applied to claims 1, 13, and 15 above, and further in view of Someya et al. (U. S. Patent No. 6,967,013).**

Resasco et al. is relied upon for their teachings with respect to claims 1, 13, and 15. Although this reference discloses exemplary supports such as those recited in claims 13 and 15, the reference does not teach or suggest the limitations recited in claims 14, 16, 17, and 26.

Someya et al. disclose a process for producing aligned carbon nanotube films, wherein a carbon compound is decomposed using a substrate coated with an element having no catalytic activity by itself (considered to read upon the limitation "buffer layer" in **claim 17**), and which loads a metallic element having catalytic ability or a compound thereof, thereby forming a film of fine carbon nanotubes on the surface of the substrate which are aligned in a direction perpendicular to the substrate. See the Abstract of Someya et al., as well as col. 2, lines 49-58.

The substrate can be formed of silica, alumina, aluminum, etc. See col. 2, lines 59-64 of Someya et al. (considered to read upon the limitation "aluminium" in **claim 14**).

Examples of the metallic element having catalytic ability include cobalt, nickel, iron, or a mixture of cobalt and nickel, in the form of particles generally having sizes between 0.1 and 50 nm. See col. 3, lines 32-44 of Someya et al. (considered reading upon claims 4-6; noting that these elements are also disclosed in Resasco et al.).

In Example 1 of Someya et al., a square substrate measuring 2 mm thick and 75 mm on each side (considered to read upon "one dimension smaller than the other two dimensions" in **claim 16**) having aluminum deposited thereon by vacuum deposition is prepared.

Patentees' process also involves carbon compounds such as saturated hydrocarbons, oxygen-containing hydrocarbon compounds (e.g., methane, ethane, propane, etc.; compounds the same as, or similar to, those recited in Resasco et al. and recited in Applicants' **claims 24 and 25**) introduced in gaseous form or in mixture with an inert gas; the carbon compound may also be mixed with a compound containing a hetero element such as boron or nitrogen (considered to read upon **claim 26**). The aforementioned carbon compounds are decomposed via pyrolysis at reaction temperatures between 400°C and 1100°C (comparable to the temperature range recited in Resasco et al.). See col. 4, line 60 to col. 5, line 12 of Someya et al.

In view of the similarities between Someya et al. and Resasco et al. regarding the respective methods/conditions of producing carbon nanotubes and the respective catalysts disclosed therein, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Resasco et al. by incorporating therein the substrates disclosed in Someya et al., as both respective substrates are known in the art of producing carbon nanotubes.

**10. Claims 20-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over WO 00/17102 or Resasco et al. as applied to claims 1 and 9 above, and further in view of Arakawa (U. S. Patent No. 4,572,813).**

Resasco et al. is relied upon for their teachings with respect to claims 1 and 9. Although Resasco et al. additionally read upon claims 20-22, 24, and 25, this reference does not teach or suggest the limitations of claims 27 and 28.

Arakawa teaches a process for preparing carbon fibers by reacting a mixed gas consisting of a gas of organic metal compound or compounds, a carrier gas, and desirably a gas of carbon compound or compounds at temperatures ranging between 600° to 1300°C (comparable to the temperatures disclosed in Resasco et al.), in which fibers having a diameter of 0.05 to 2  $\mu\text{m}$ , a length of 2-3000  $\mu\text{m}$ , and an aspect ratio of 2 to 30,000 may be produced. See the Abstract of Arakawa.

Examples of the organic metal compounds include carbonyl compounds of metals such as iron, cobalt, and nickel; specific examples include iron pentacarbonyl ( $\text{Fe}(\text{CO})_5$ ), nickel tetracarbonyl ( $\text{Ni}(\text{CO})_4$ ). See col. 2, line 49 to col. 3, line 41 of Arakawa (considered to read upon **claims 20-23**).

The carrier gas may be an inert gas, such as nitrogen. See col. 3, lines 42-50 of Arakawa (considered to read upon **claims 26 and 29**).

Examples of the carbon compound or compounds (used as a carbon source) include carbon monoxide (CO), alkanes such as methane and ethane, alkenes such as ethylene, alkynes such as acetylene, aryl hydrocarbons such as benzene and toluene, aromatic hydrocarbons such as naphthalene, and heterocyclic compounds such as

thiophene. A mixture of these compounds may also be used. Further, the carbon compound may also contain nitrogen and other elements. See col. 3, line 51 to col. 4, line 14 of Arakawa (considered to read upon **claims 24, 25, 27 and 28**).

In view of the similarities between Arakawa and Resasco et al. regarding the respective components employed in methods of producing carbon nanotubes, and the respective catalyst precursors disclosed therein, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Resasco et al. by incorporating therein the catalyst precursors disclosed in Arakawa, as the respective catalyst precursors are known in the art of producing carbon nanotubes.

Further, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Resasco et al. by incorporating therein thiophene, as suggested by Arakawa, because both Resasco et al. and Arakawa teach the same or similar carbon-containing compounds as carbon sources, in the references' respective methods for producing carbon nanotubes.

### ***Conclusion***

11. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to PATRICIA L. HAILEY whose telephone number is (571)272-1369. The examiner can normally be reached on Mondays-Fridays, from 7:00 a.m. to 3:30 p.m.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jerry Lorengo, can be reached on (571) 272-1233. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group 1700 Receptionist, whose telephone number is (571) 272-1700.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/PATRICIA L. HAILEY//P. L. H./  
Examiner, Art Unit 1793  
February 22, 2008